Advisory Committee on Energy Efficiency

Energy efficiency standards for improving and optimising the energy consumption of electric driven machine units

The webinar will start in a few minutes...

November 22nd, 2021

Philippe Vollet, Maarten van Werkhoven & Conrad U. Brunner

IEC Academy Webinar on ACEE and CAISEMS

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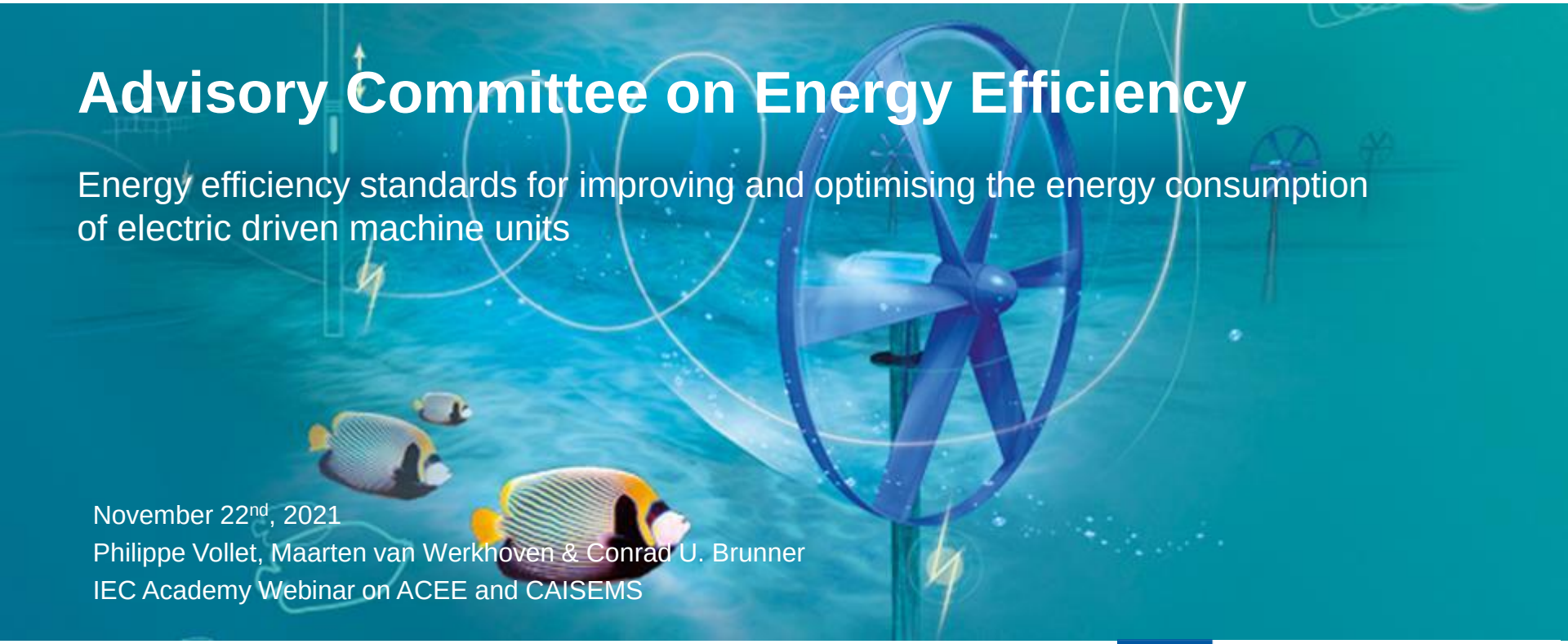
Academy & Capacity Building

Advisory Committee on Energy Efficiency

Energy efficiency standards for improving and optimising the energy consumption of electric driven machine units



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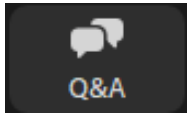
Information

Please use the Q&A function for questions 

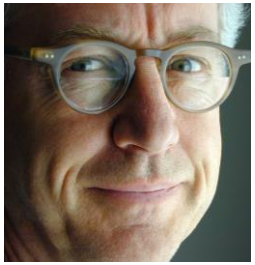
All questions will be answered after the webinar and uploaded as Q&A to www.iec.ch/academy

Slides, Q&A and recording will be available after the webinar at www.iec.ch/academy

Speakers

Philippe Vollet
IEC ACEE Chairman – IEC SC23K Secretary
He has been working for Schneider Electric since 1989, at several positions from Engineering , Business Development, Offer management and Strategy for both Low and Medium Voltage divisions.
He has been involved in standards work since 2013, mainly in Energy Efficiency and Smart Building topics.

Maarten van Werkhoven
Independent consultant on energy efficiency, research and technology in industry and commerce.
Acting as Operating Agent of the IEA Technical Cooperation Program 4E Electric Motor Systems Annex EMSA. Maarten is member of IEC ACEE, convenor of Task Group 6, and member of JAG22.



Conrad U. Brunner
Independent energy efficiency consultant, based in Switzerland. Main area of research, consultancy and advice in electric efficiency in industrial machines, like motors, variable frequency converters, and also pumps and fans.
Member of IEC ACEE and JAG22, and of ISO TC 115 for pumps and ISO TC 117 for fans.
Focus is to have the know-how of mechanical and electrical engineering combined in order to build and operate energy efficient electric machines.

IEC ACEE
Energy efficiency standards for improving and optimising the energy consumption of electric driven machine units

Agenda

- ✓ IEC ACEE: Introduction
  Philippe Vollet
- ✓ IEC ACEE TG6: Project CAISEMS
  Maarten van Werkhoven
- ✓ IEC ACEE TG6: Efficient motor systems: when IEC and ISO collaborate
  Conrad U. Brunner

IEC ACEE
Introduction

Presentation

Philippe Vollet
ACEE Chair

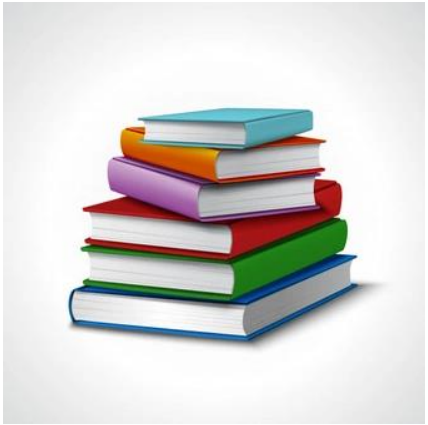
ACEE – ID Card

- ✓ ACEE deals with energy efficiency matters **which are not specific to one single technical committee** of the IEC.
- ✓ ACEE provides **guidance for implementation.**
- ✓ It encourages a **systems perspective.**

(Extracts)

- ✓ 8 Members nominated by NCs:
  CA, CH, CN, IT, JP, KR, NL, US
- ✓ 8 Members nominated by Entities:
  TC 9, TC 14, TC 23, TC 27, TC 64, TC 66, TC85, TC 121
- ✓ 1 Internal IEC Liaison:
  IECEE

ACEE – ID Card



- ✓ **IEC Guide 118:2017 - Inclusion of energy efficiency aspects in electrotechnical publications:**

  Guidance on how to consider energy efficiency aspects when preparing IEC publications

- ✓ **IEC Guide 119:2017 - Preparation of energy efficiency publications and the use of basic energy efficiency publications and group energy efficiency publications:**

  Procedures for the preparation of energy efficiency (EE) publications
  Relationship between technical committees (TCs) with group EE functions.

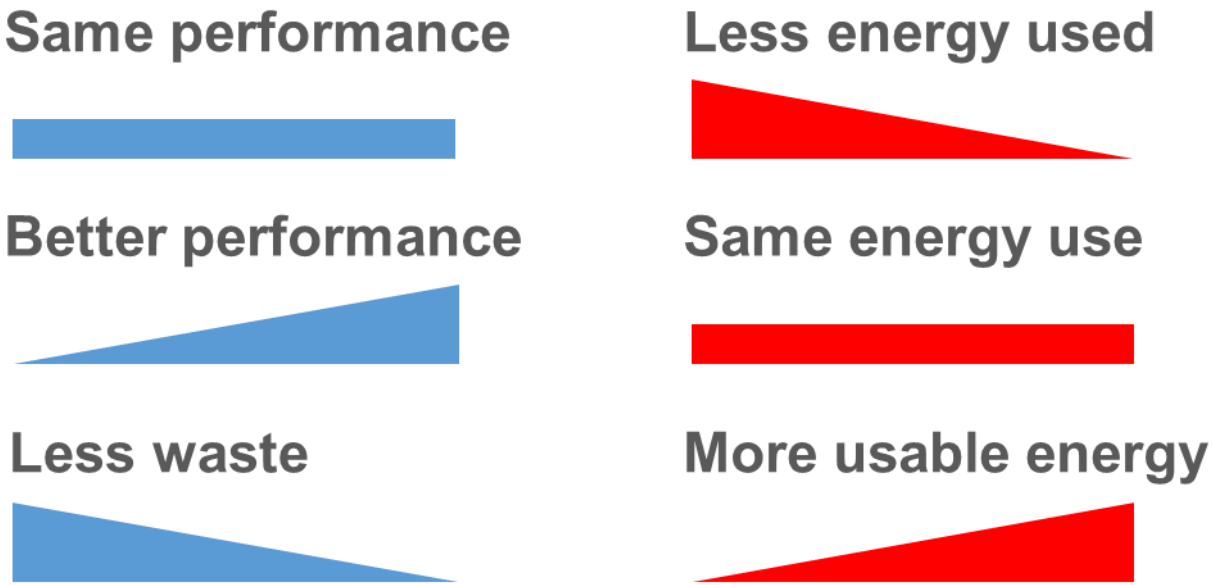
- ✓ **Energy Efficiency Functions** *(SMB/6523A/RV & SMB/6791A/RV)*

  TC64 : *Guidelines for energy efficiency of low-voltage electrical installation.*

  SC 22G: *in the context of the development of IEC 61800-9-1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA) and semi analytical model (SAM)*

IEC Advisory Committee on Energy Efficiency
Definition of energy efficiency (IEC ACEE Guide 118)

Ratio: **output of performance** vs. **input of energy**



ACEE- IEC Academy Webinars

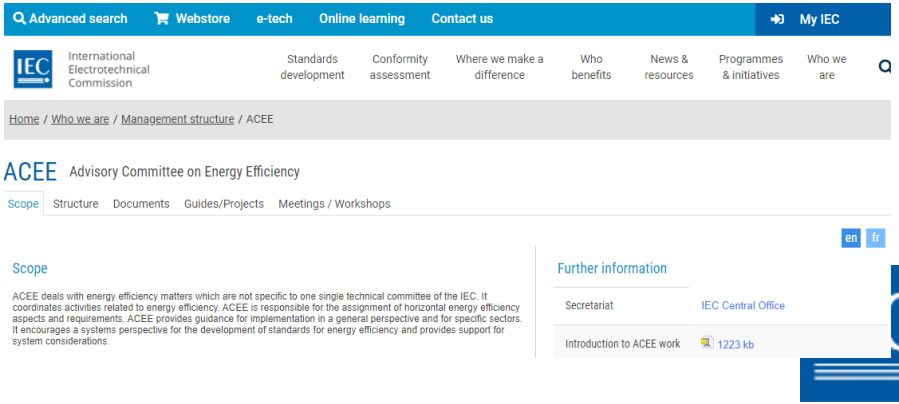
- ✓ **Webinar 1: June 23, 2020**
  - ACEE - Energy Efficiency
    Key Principles, terminology and good practice for use in electrotechnical publications
- ✓ **Webinar 2: September 22, 2020**
  - ACEE - Energy Efficiency
    Case study on low-voltage electrical installations
  - Case study on electric motors

- **Webinar 3: November 22, 2021**
  - **Project CAISEMS**
  - **Efficient motor systems: when IEC and ISO collaborate**

Energy efficiency standards for improving and optimising the energy consumption of electric driven machine units

Please, to know more: feel free to:

- to download the previous webinars on the IEC academy webpages
- to visit our ACEE webpages



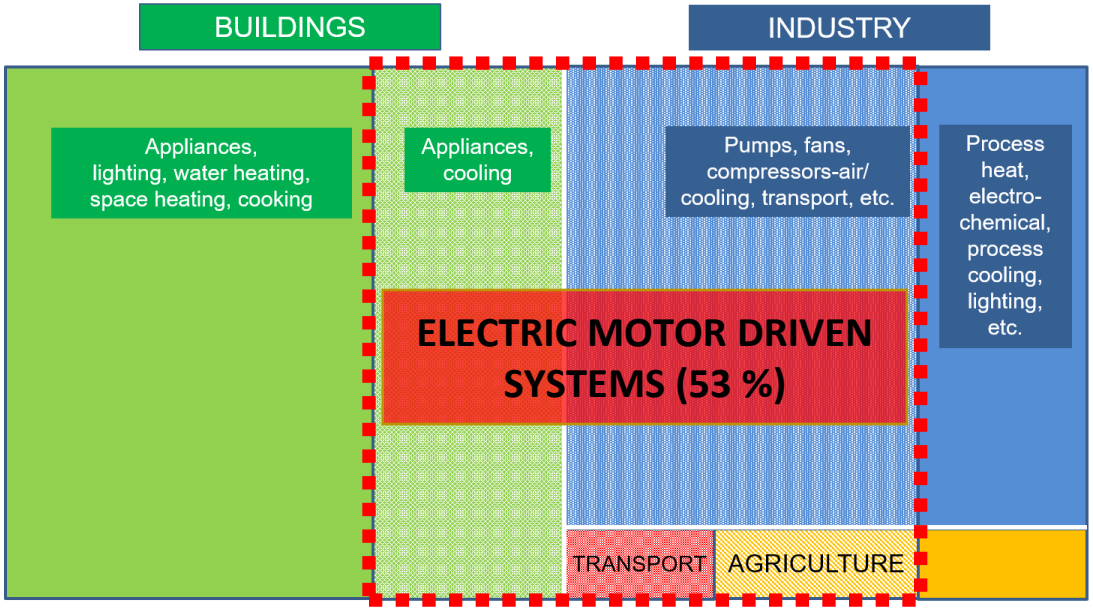
IEC ACEE
Project CAISEMS

Presentation

Maarten van Werkhoven

IEC ACEE member

Global electricity end-use ► Motors and Appliances



Global end-use electricity: IEA WEO 2016

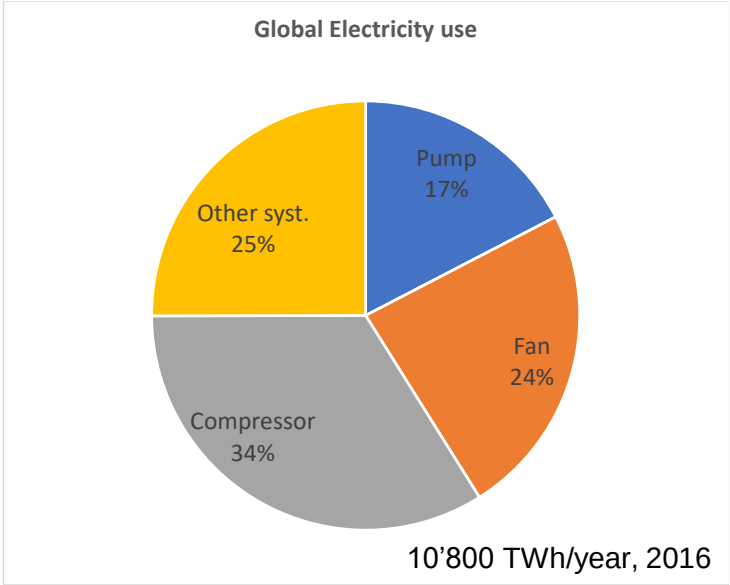
Electric motors

Electric motors drive

- **pumps**
- **fans**
- **compressors**
- **transport systems**
- **handling & process systems**
- **others**

Motors are responsible for 53% of global electricity use

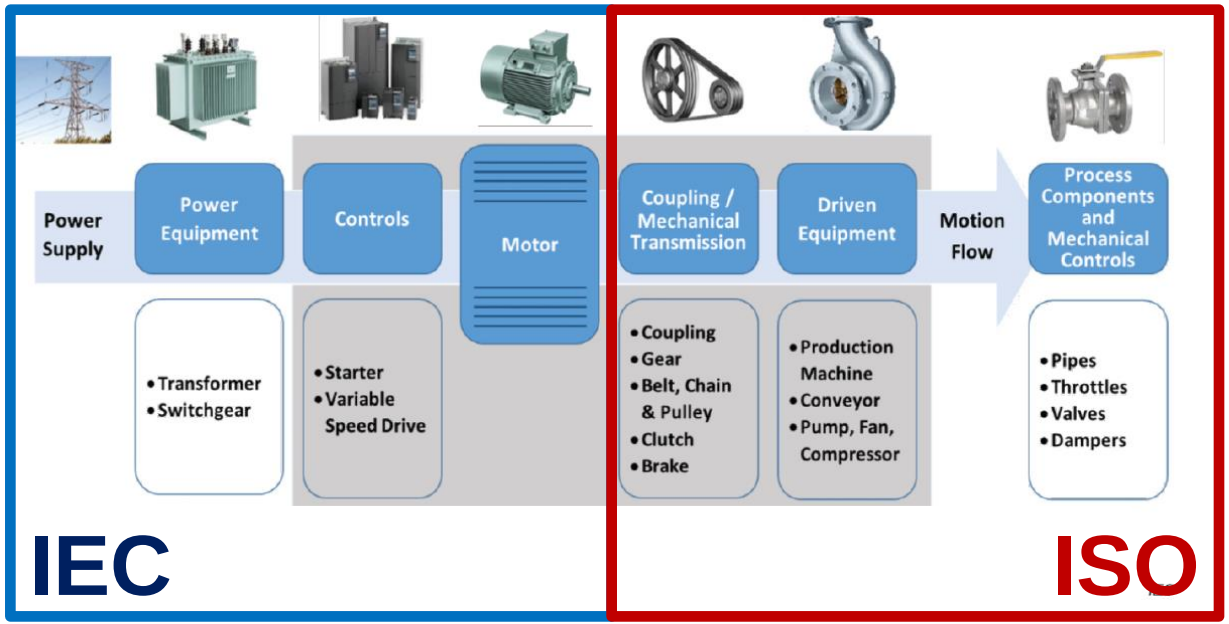
- **Industry: share 60-70%**



10’800 TWh/year, 2016

IEA World Energy Outlook 2016

System standards - energy efficiency



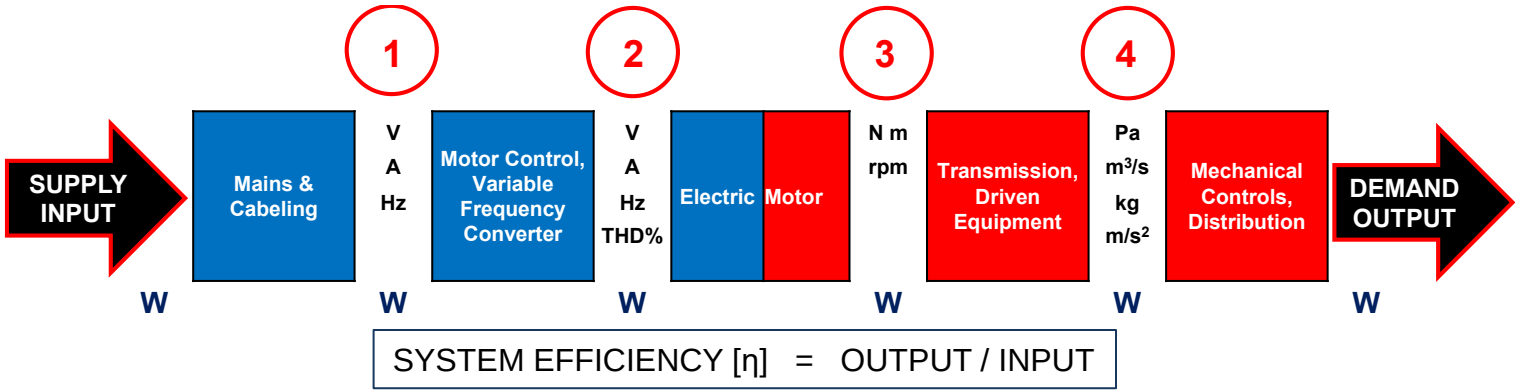
Standardization bodies

Motor control		Motor	Mechanical equipment		Driven equipment			
IEC TC 121	IEC TC 22 SC 22G	IEC TC 2	ISO TC 41	ISO TC 60	ISO TC115	ISO TC 117	ISO TC 86	ISO TC 118
Switchgear & controlgear	Adjustable speed drive	Rotating machinery	Pulleys & belts	Gears	Pumps	Fans	Cooling-Com-pressors	Air-Com-pressors
1927	1934	1911	1947	1947	1964	1964	1957	1965

Energy efficiency standards:

- **definition of scope**
- **testing standards**
- **efficiency classification**

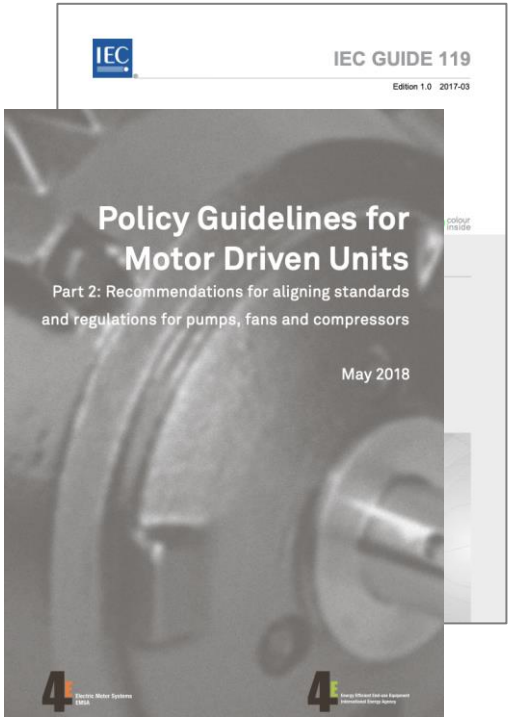
Complexity of EMDS (constant and variable load)



- **Cooperation: planning, assembly, testing, operation**
- **System optimization has big advantages:**
  - **Lighter, smaller, cheaper**
  - **High reliability**
  - **Less waste heat ► more energy efficient**
  - **Lower peak load (kW)**
  - **Lower electricity consumption (kWh) and cost (EUR)**
  - **Improved controls: Start/Stop; peak and part load; hours of operation**

Background

- IEC ACEE Guide 119, systems approach (2017)
- 4E EMSA: policy guidelines for motor driven systems (EMDS), recommendations for policy makers (2018)
- IEC ACEE: systems considerations for EMDS (2018/19)
- Workshop Sept. 2019 – start of CAISEMS



System Standards: the CAISEMS project

IEC ACEE (Advisory Committee on Energy Efficiency), Task Group 6

- **CAISEMS: coordination and alignment of standards for energy efficient electric motor driven systems**
- **Goal: cooperation between IEC and ISO, provide a platform to facilitate coordination and alignment**
- **1st meeting 20 September 2019 in Tokyo, Japan**
  - **25 participants**
- **6th meeting: 20 September 2021, teleconference**

Goals and Benefits

CAISEMS Goals

- solid overview of existing IEC and ISO standards for energy efficiency of EMDS
- platform for systems: "wire-to-water / air"
- system calculation of efficiency/losses (ex ante):
  COMPONENTS ► SYSTEM
- interface:
  MOTOR SYSTEM ►◄ DRIVEN SYSTEM
- system acceptance test (ex post)
- calculation allows any operating point

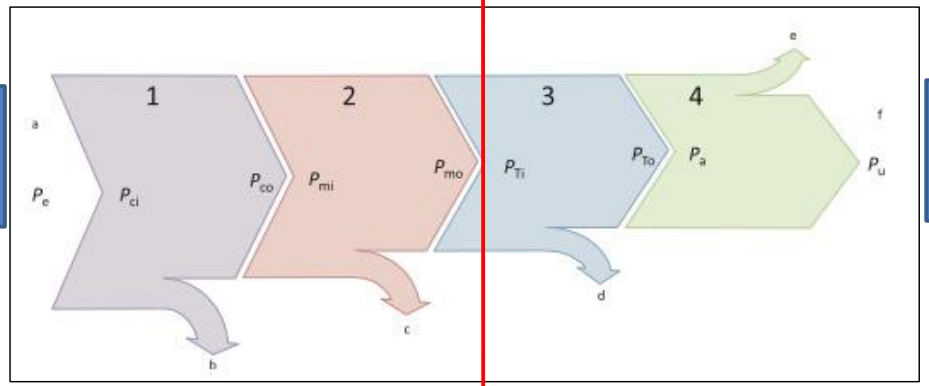
CAISEMS Benefits

- Facilitating systems optimization through transparency between standards, referencing
- *exchange of information* among IEC and ISO TCs to explore relevant opportunities for coherence, convergence and complementarity
- avoid duplication, unnecessary redundancy or diverging and conflicting elements ► ensuring the “interoperability” of the different standards falling into EMDS boundaries
- Each ISO and IEC product TC may have different energy metrics for its product, but all these metrics should find a general combined applicability when it comes to specifying system performance

Example: Fan system power losses

(Source: ISO 12759-2, 2019)

Wire



Water

Air

on-site assembly

Key

1 control
2 motor
3 transmission
4 fan

a Input power.
b Control losses.
c Motor losses.
d Transmission losses.
e Fan losses.
f Fan air power.

Test, Calculate - Ex Ante

Test, Calculate - Ex Post

Work CAISEMS, 2019-2021

- CAISEMS: 60 members (contributing actively / monitoring)
- Liaisons and cooperation with IEC and ISO TCs
- Background Document 2020 (overview of Standards, Scope, Metrics, Operating Points, MEPS-requirements) (see www.IEC.ch/ACEE)
- 2021 -> preparing for start of a formal ISO & IEC Joint Entity, by 3 founding IEC and ISO TCs:
  - IEC TC 2: motors
  - IEC TC 22/SC22G: VFDs/power drive systems
  - ISO TC 117: fans
- Formal kick off on 19 October 2021

ISO & IEC Joint Advisory Group JAG 22

Optimized Energy and Power Consumption of Electric Driven Machine Units [e.g. pump, fan, compressor]

Calculation and measurement of energy losses in electro-mechanical systems

- **To facilitate the exchange and coordination between ISO and IEC in the field of all types of Electric Driven Machine Units (EDMU).**
- **To identify the relevant coordination issues and proposed solutions and describe these considerations or results of such exchange and coordination discussions for guidance, reference.**
- **If the committees involved identify the need for producing a document, this can get the format of a Technical Report.**

The JAG is a joint IEC and ISO advisory group (JAG) involving IEC SC 22G (converters, secretariat), IEC TC 2 (motors) and ISO TC 117 (fans). ISO TC 115 (pumps) and ISO TC 118 (compressors) are invited to participate, as well as any other interested ISO and IEC committee. Members are nominated experts from the concerning NCs and up to two members delegated by each of the concerning committees.

JAG 22

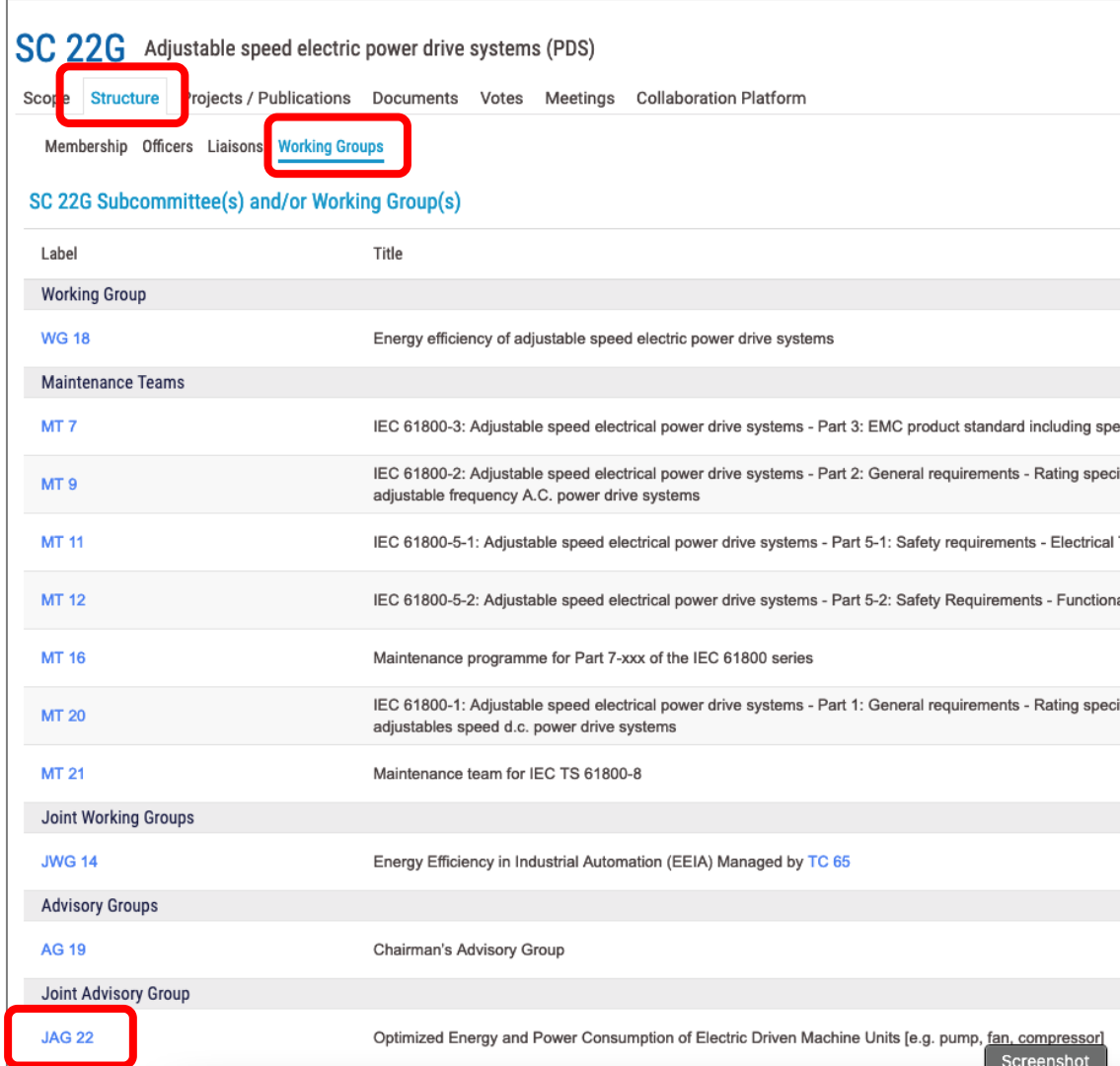
See IEC ACEE WebSite

@www.iec.ch/

/Standardsdevelopment

/List of TCs/SCs

/SC22G



Take aways

- Efficient Electric Motor Systems can contribute substantially to climate goals
- Internationally coordinated standards make it easier for national governments to establish minimum requirements for efficient products
- Making the step from product to system makes this an even more important prerequisite
- IEC (electric) and ISO (mechanical) Standard Committees need to interact more closely, to deal with energy efficiency in Electric Motor Driven Systems in a timely fashion

IEC ACEE

Coordination Example TC2 & TC117

Presentation

Conrad U. Brunner

IEC ACEE member

Conclusion

Q&A

Philippe Vollet

Maarten van Werkhoven

Conrad U. Brunner

Thank you for your attention !

Any Questions and/or Remarks ?

Thank you!

Philippe Vollet
Maarten van Werkhoven
Conrad U. Brunner
IEC ACEE

ACEE Webinar
22 November 2021

International Electrotechnical Commission

International Electrotechnical Commission

Academy & Capacity Building

Efficient motor systems:

when IEC and ISO collaborate

IEC ACADEMY
22 November 2021

Conrad U. Brunner
Switzerland

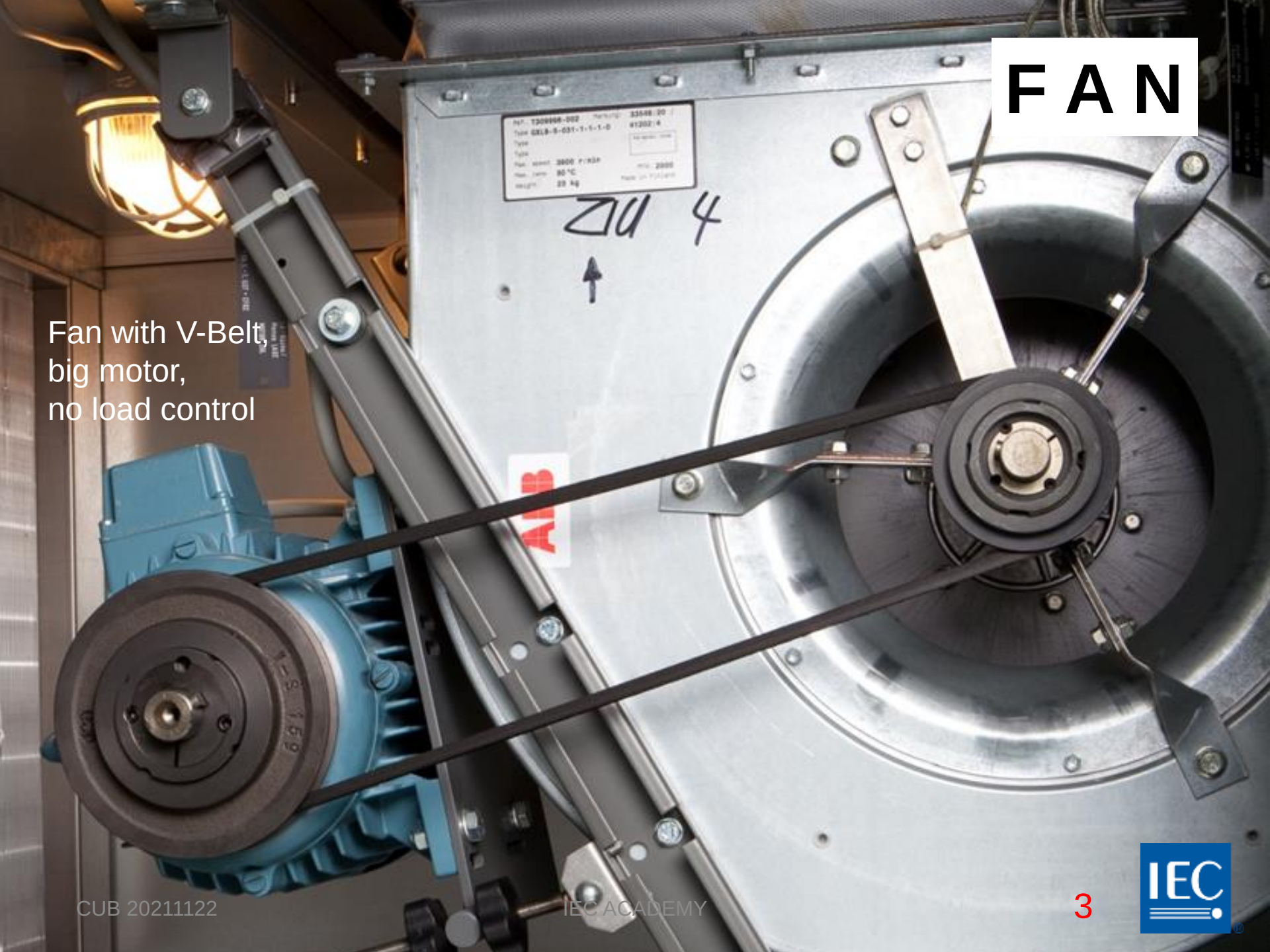
CAISEMS
Coordination and alignment of IEC and ISO standards for energy efficient electric motor driven systems

Coordinator: IEC Advisory Committee on Energy Efficiency ACEE - Task Group 6

This means for industrial motor systems:

1. Reduce to necessary demand: pressure and flow, capacity, temperature, etc.
2. Downsize all components to actual demand.
3. Use only when necessary.
4. Load control is imperative.
5. Go to direct-drive wherever possible.

FAN



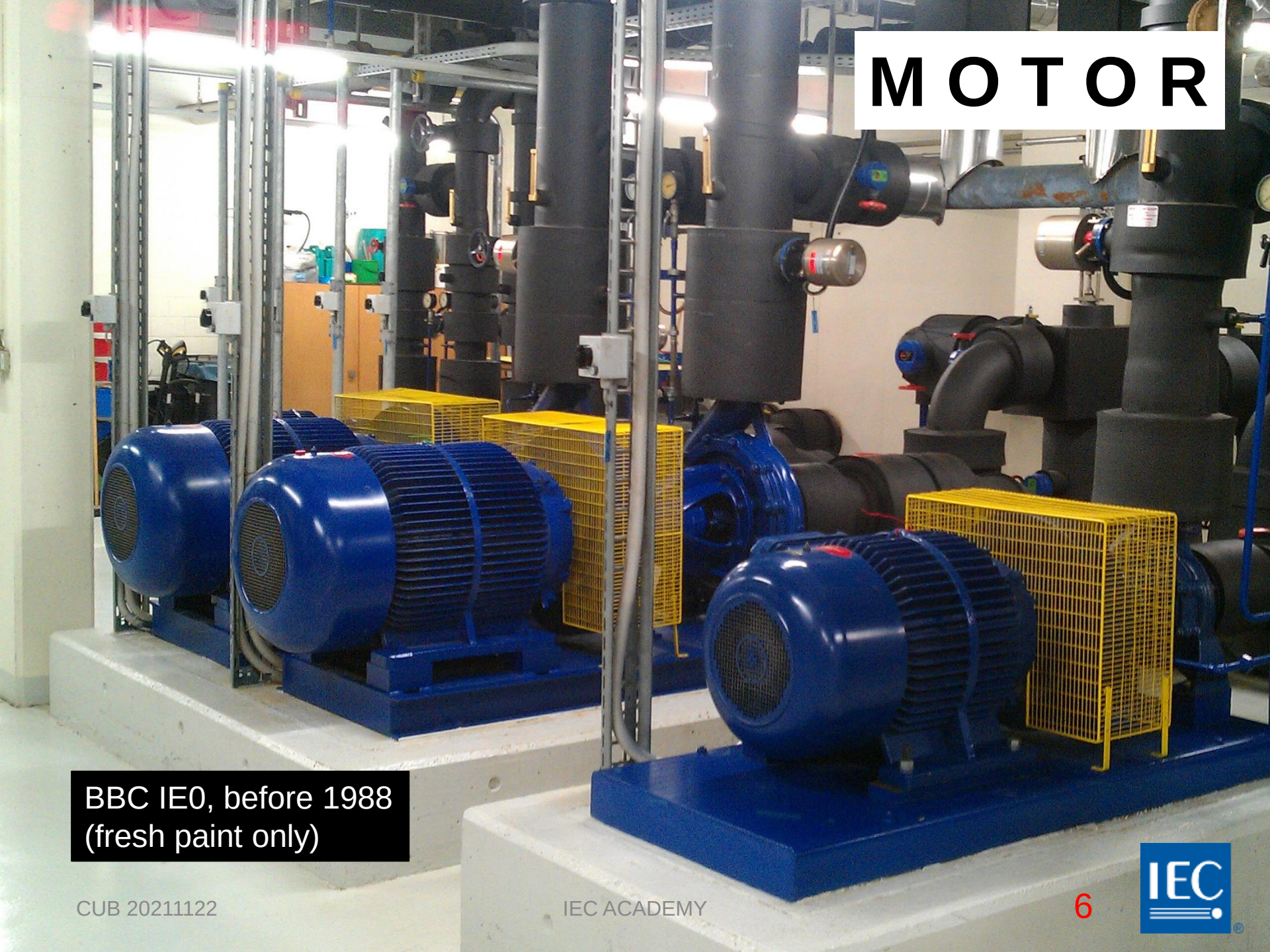
Fan with V-Belt,
big motor,
no load control

https://www.engineerlive.com/content/industrial-pump-survival-guide-beginners

AIR-COMPRESSOR

Zhengzhou Kaishan
JN Series Energy-Saving Two-Stage Screw Air Compressor

MOTOR

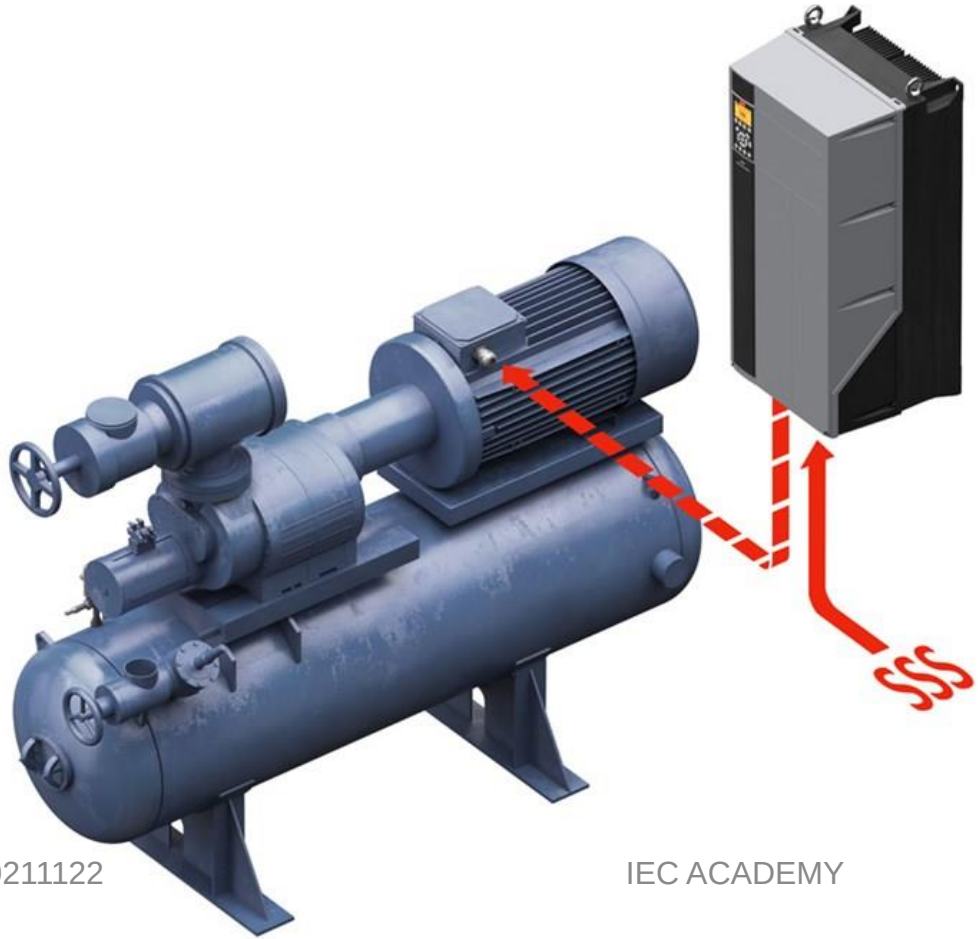


BBC IE0, before 1988
(fresh paint only)

MOTOR

ABB IE5 SynRM

VARIABLE FREQUENCY CONVERTER



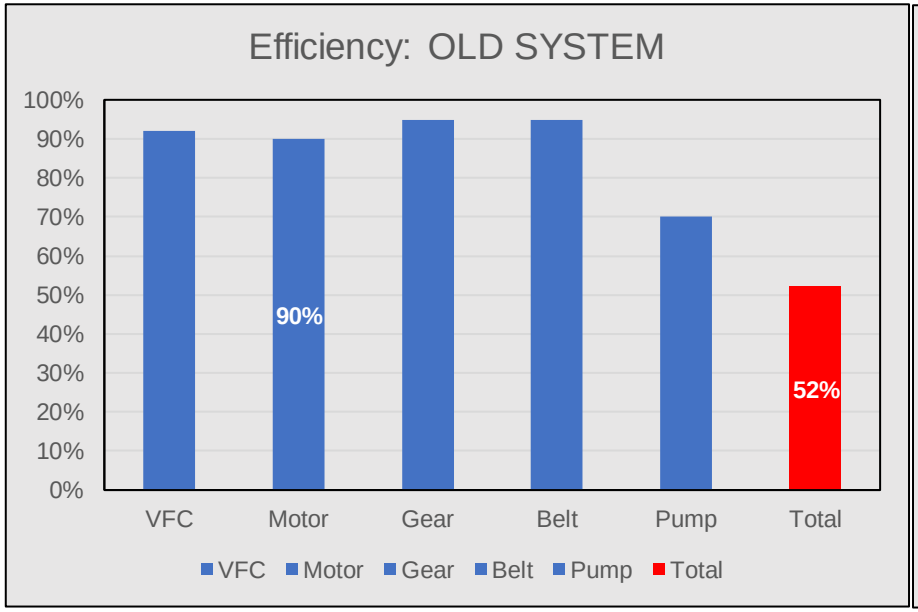
Danfoss VFC with screw compressor

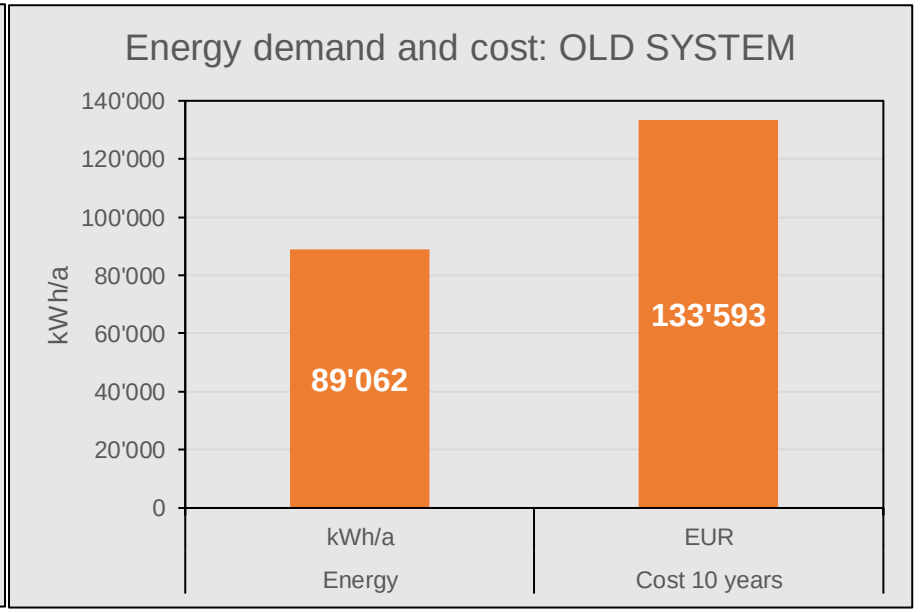
THE #1 CASE
The outset

- Any 10 kW nominal output machine,
- could be a pump, a fan, or anything that rotates.

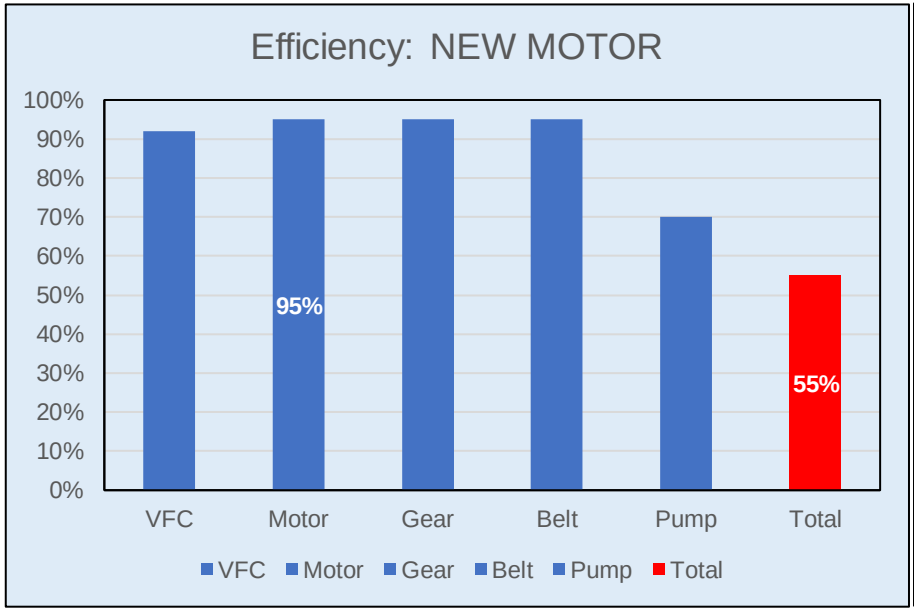
- The machine at the outset:
  Oversized, with fixed speed, with gear and V-belt, current market components.
- the system improved:
  Downsized, with adjustable speed, direct drive, efficient components, operated only when needed.

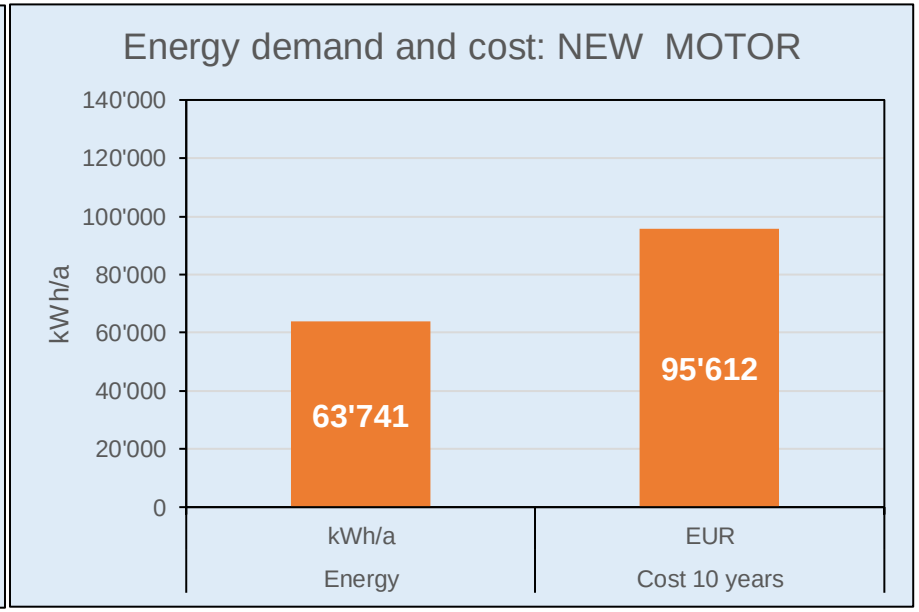
OLD SYSTEM


Efficiency: OLD SYSTEM
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
90%
52%
VFC
Motor
Gear
Belt
Pump
Total
VFC Motor Gear Belt Pump Total

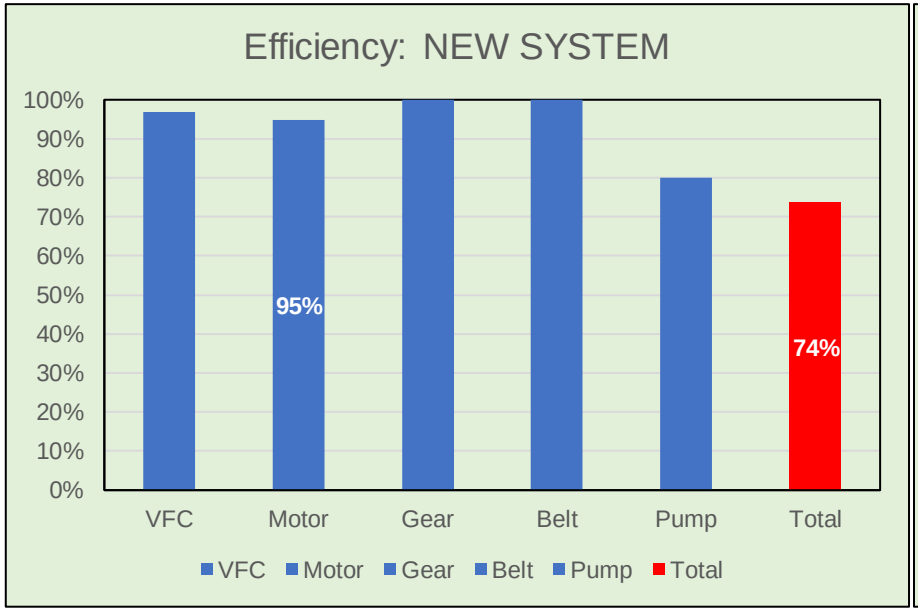

Energy demand and cost: OLD SYSTEM
140'000
120'000
100'000
80'000
60'000
40'000
20'000
0
kWh/a
89'062
133'593
kWh/a
Energy
EUR
Cost 10 years

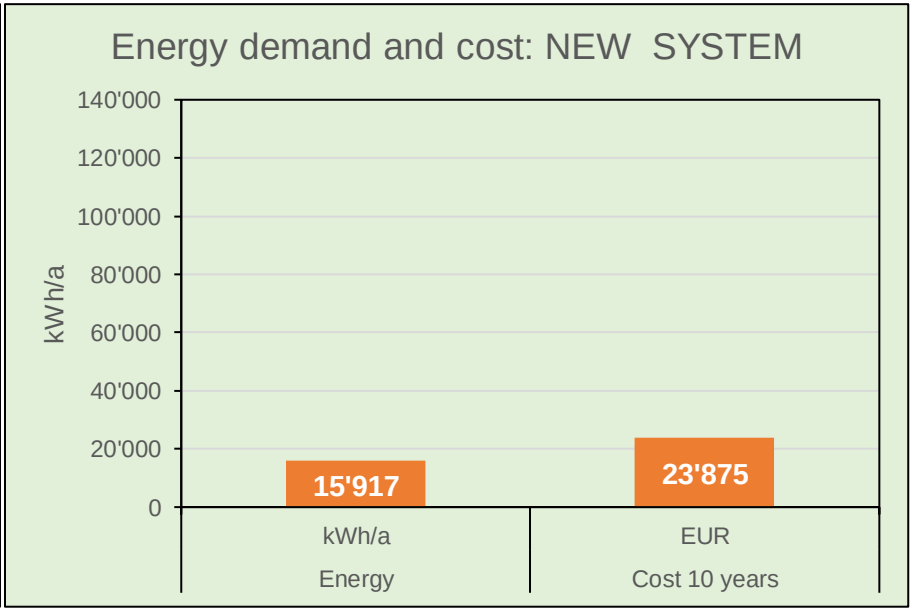
ONLY NEW MOTOR





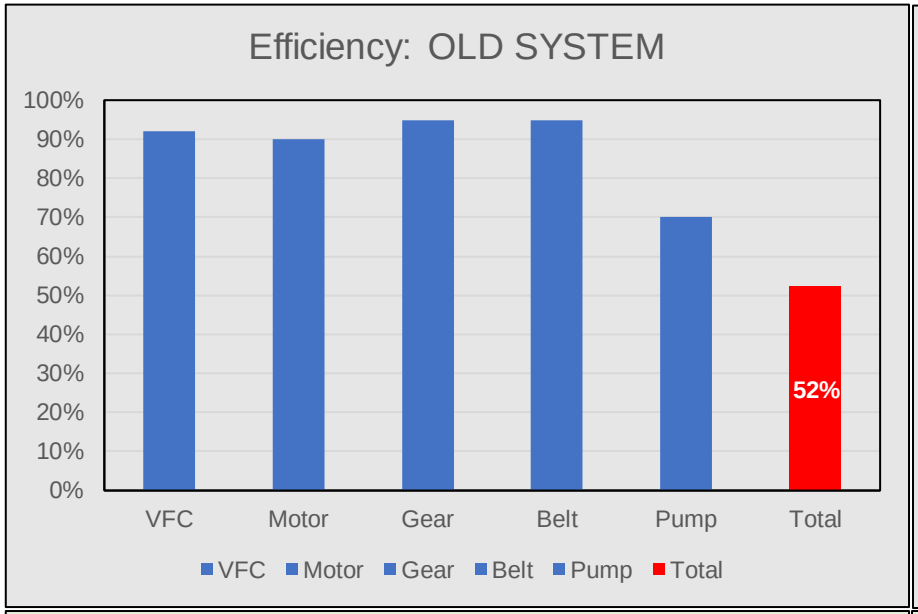
THE NEW SYSTEM

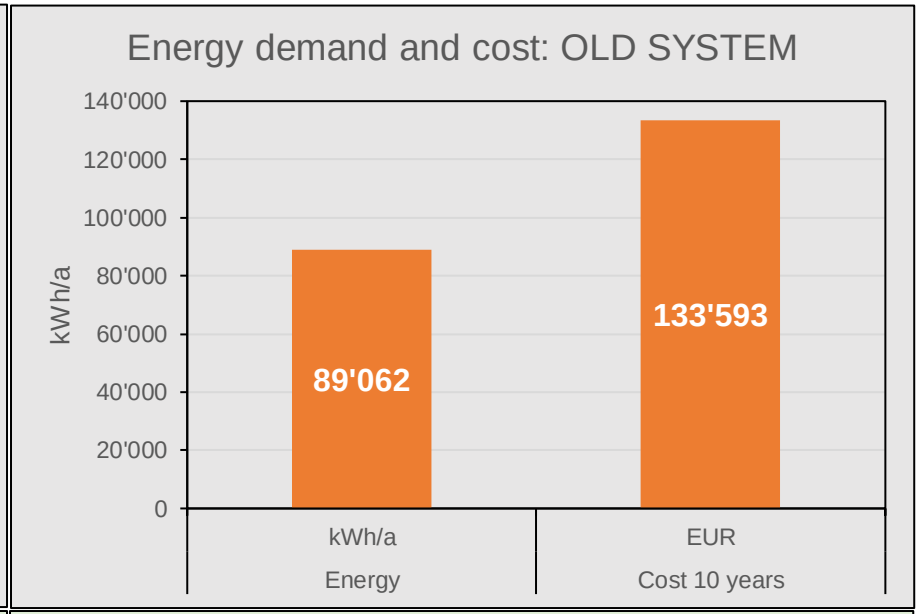


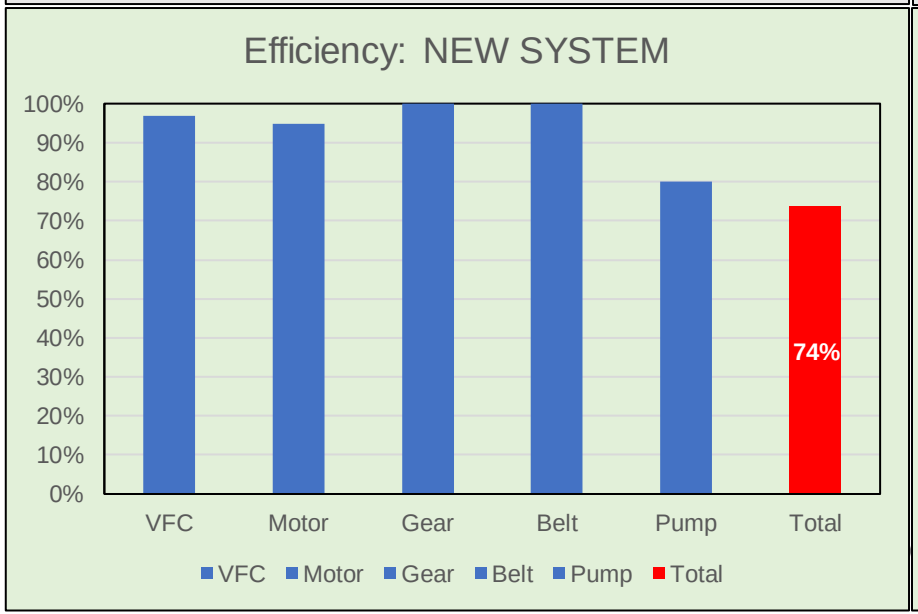


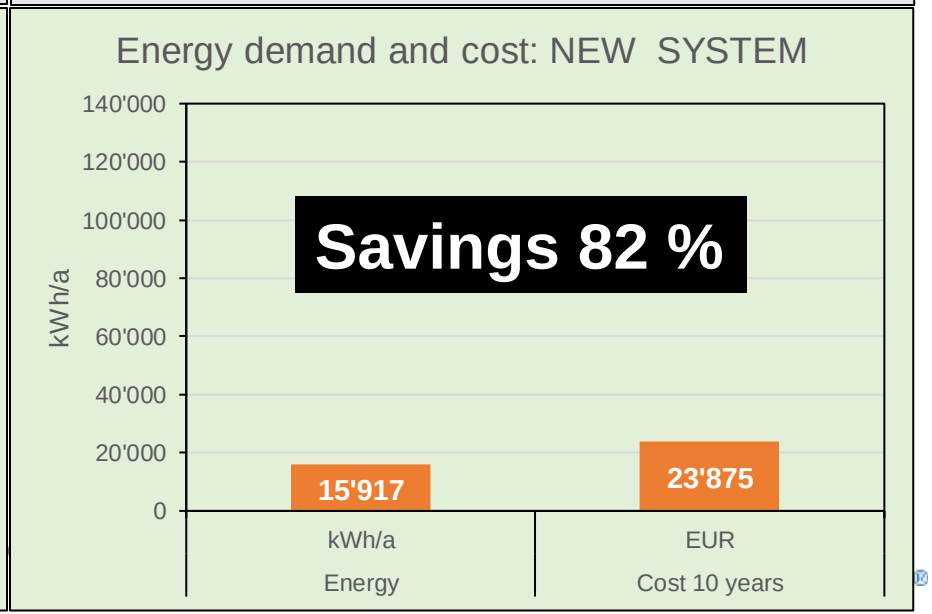
- coordinated components
- 5 kW motor instead of 10 kW
- 3500 h/a of operation instead of 4500 h/a
- 74 % total system efficiency instead of 52 %

POSSIBLE ENERGY SAVINGS









THE #1 CASE
What we have learned

- electric energy savings: up to 82%
- energy cost savings: up to EUR 109'000 in 10 years

What you need to buy:

• a new 5 kW IE4 motor	EUR	1'000	
• a new 5 kW IE3 VFC	EUR	1'000	EUR
• a new 5 kW pump/fan	EUR	2'000	8'000
• get it installed and adapted*	EUR	4'000	

► that is only around ONE YEAR PAYBACK

Conclusion: money is often NOT the barrier!

*) 2 mechanics in four days: 32*100 EUR

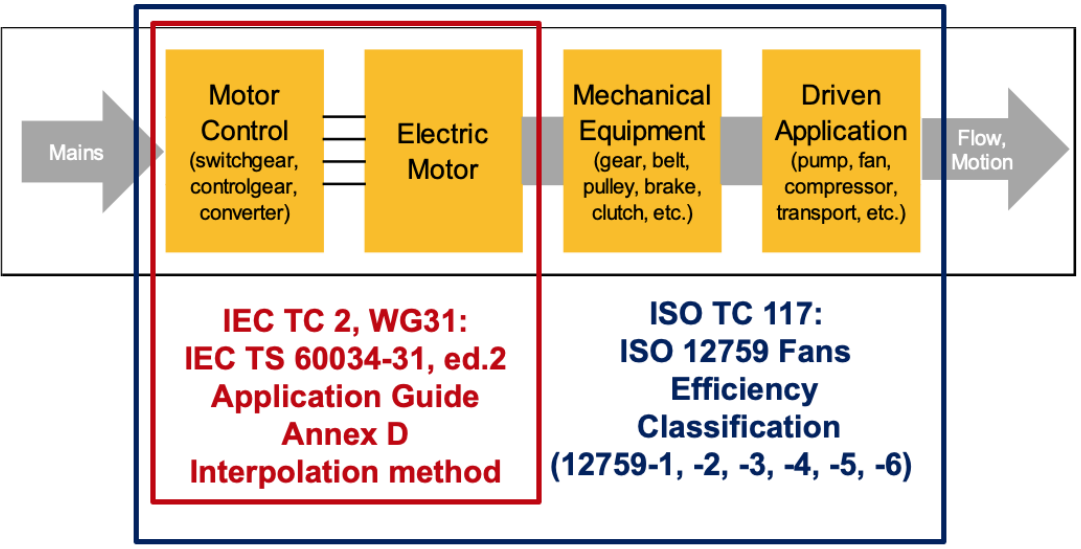
THE NEW SYSTEM MEANS

1. Supply meets demand: no more oversizing
2. Time of use: run only when needed (night, weekend)
3. No standby losses
4. Motor connects to pump/fan directly:

   ► direct drive, no gear and belt necessary
5. Load control at any time is necessary: VFC
6. Use high efficient components:
   - motors: IE4
   - VFC: IE2 or IE3
   - BAT for pumps and fans

Example IEC & ISO cooperation

Update IEC and ISO



New Interpolation Method
IEC TS 60034-31

IEC TC 2 Chair:
- Martin Doppelbauer

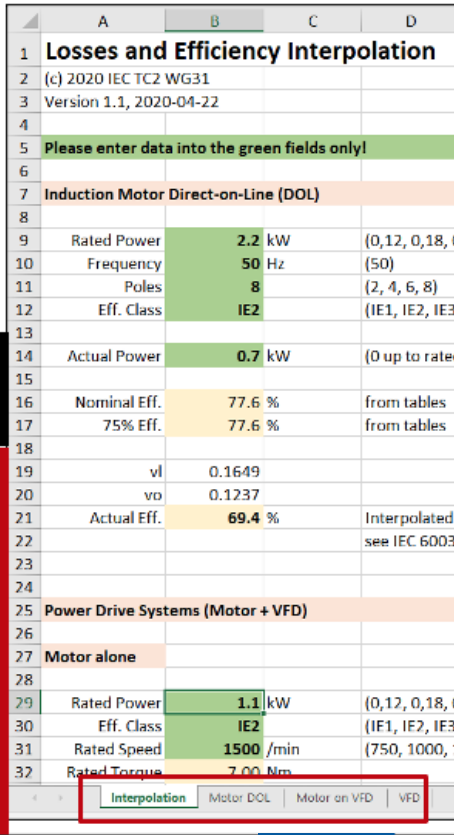
WG 31:
- project leader Calc.Sheet: Freddy Gyllensten

Annex (informative)
Calculation sheet for losses and efficiency interpolation

- Motor alone
- VFD
- Motor + VFD

- 0.12 kW - 1000 kW
- 50 Hz / 60 Hz
- 2-, 4-, 6-, 8-poles

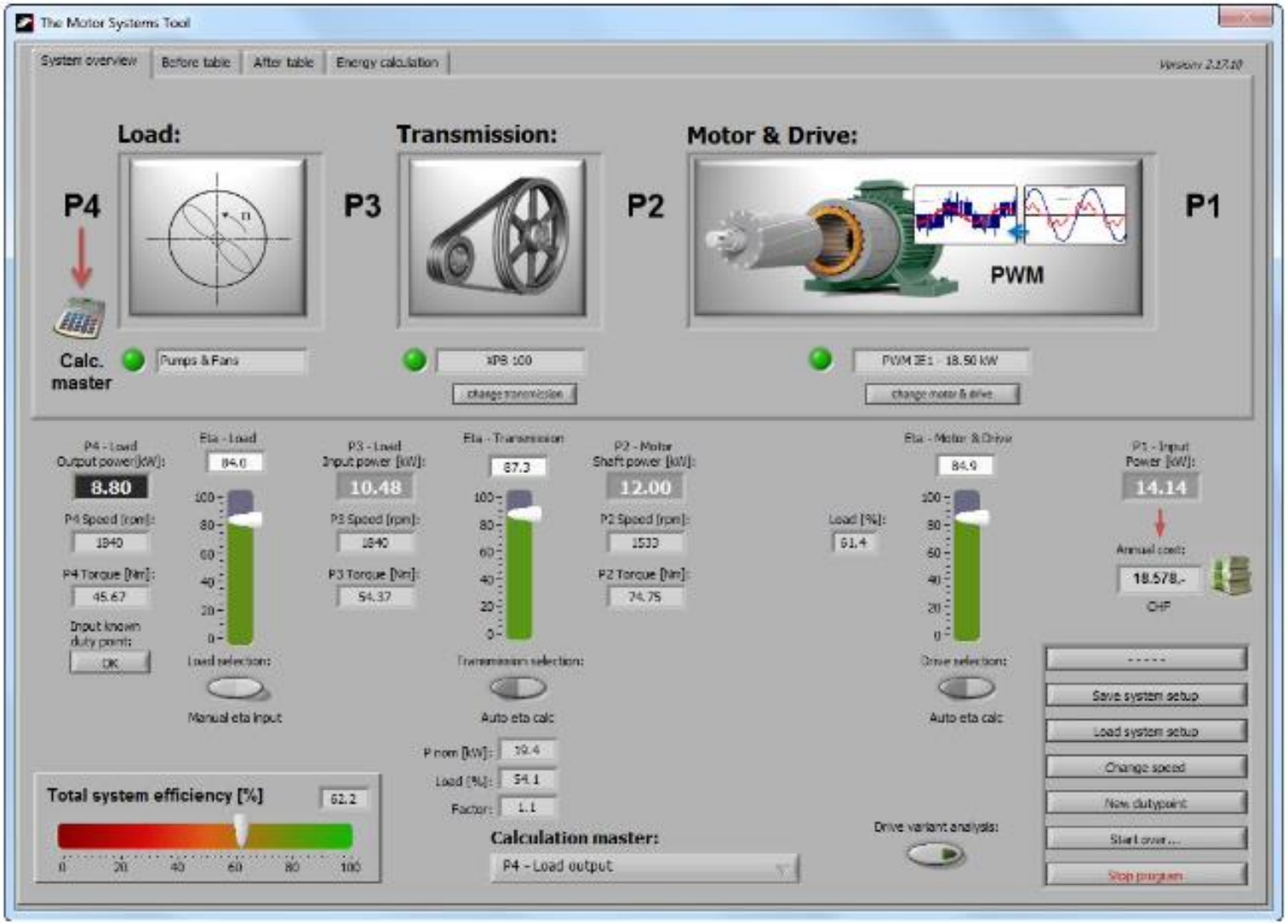
- Motors IE1 … IE4
- VFD IE1 … IE3
- 0% …. 100% rated power



	A	B	C	D
1	**Losses and Efficiency Interpolation**			
2	(c) 2020 IEC TC2 WG31			
3	Version 1.1, 2020-04-22			
4				
5	**Please enter data into the green fields only!**			
6				
7	**Induction Motor Direct-on-Line (DOL)**			
8				
9	Rated Power	**2.2**	kW	(0,12, 0,18,
10	Frequency	**50**	Hz	(50)
11	Poles	**8**		(2, 4, 6, 8)
12	Eff. Class	**IE2**		(IE1, IE2, IE3
13				
14	Actual Power	**0.7**	kW	(0 up to rate
15				
16	Nominal Eff.	77.6	%	from tables
17	75% Eff.	77.6	%	from tables
18				
19	vl	0.1649		
20	vo	0.1237		
21	Actual Eff.	**69.4**	%	Interpolated
22				see IEC 6003
23				
24				
25	**Power Drive Systems (Motor + VFD)**			
26				
27	**Motor alone**			
28				
29	Rated Power	**1.1**	kW	(0,12, 0,18,
30	Eff. Class	**IE2**		(IE1, IE2, IE3
31	Rated Speed	**1500**	/min	(750, 1000,
32	Rated Torque	7.00	Nm	

Interpolation | Motor DOL | Motor on VFD | VFD

System performance calculation



Source: DTI 2015

Thank you, questions?

C O N T A C T

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